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Dynamic Simulations of Tissue Welding

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Abstract

We have used coupled Monte Carlo, thermal transport and mass transport numerical models to simulate the exposure of human skin to near-infrared radiation. The computer model LATIS (LASer-TISsue) is applied in both one-dimensional and two-dimensional geometries. Zones within the skin model are comprised of a topical solder, stratum corneum, epidermis, dermis, and fatty tissue. Each skin zone is assigned initial optical, thermal and water density properties consistent with values listed in the literature. The optical properties of each zone (*i.e.* scattering, absorption and anisotropy coefficients) are modeled as a kinetic function of the temperature. The thermal properties of each zone (*i.e.* thermal conductivity and specific heat) are a dynamic function of the temperature and water content in each zone. Finally, the water content in each zone is computed from water diffusion where water losses are accounted for by evaporative losses at the air-solder/stratum corneum interface.

The simulation results show that the inclusion of water transport and evaporative losses have a significant impact on both the thermal distributions of the skin and desiccation of the surface tissues. Optimum laser parameters are identified to control the thermal profiles within the skin and, thus, the welding depth. Simulation results are compared to experimental results.

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